

IV.—Notes on the Physiography and Geology of Aroostook County, Maine.

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In a paper read before this Society in May, 1886, and entitled "On the Silurian System of Northern Maine, New Brunswick and Quebec," the author, after making certain comparisons between the rocks of these several districts, was led to express the opinion that considerable areas in Aroostook County, Maine, which have been long regarded and represented as of Devonian age, were more properly to be referred to the Silurian. Having since had an opportunity of making a more extended examination of portions of the county, as well as the regions in New Brunswick and Quebec with which the former was compared, he desires, in the present paper, to state a few additional facts which tend to confirm the opinions then expressed, and at the same time to offer a few suggestions, which may be of service to future explorers in the same field.

The portions of Aroostook County which have been personally visited by the author include the valley of St. John River, in so far as this forms a portion of the international boundary—in other words to St. Francis River, as well as beyond the latter to its tributary, the Allegash—and secondly, the country lying to the south and west of this valley, so far as it is included between Fish River and Aroostook River. It is to the latter region, lying almost wholly within the State of Maine, that more particular reference will here be made.

A glance at the topography and physical features of this region, as exhibited in any good map, will be found to reveal some features of interest, which may help to explain its geological structure. Of these, perhaps the most noticeable are the peculiar position and character of the first or eastern branch of Fish River. This latter is really little more than a chain of lakes, embracing not less than five distinct basins, Long, Mud, Square and Eagle Lakes, varying from two to twelve miles in length, and from one to two in breadth, which are connected with each other, for the most part, only by short thoroughfares. They are also very nearly upon a common level, and are bordered by land which, relatively to the lakes, has usually but little elevation. In other words, they occupy the deeper portions of a somewhat irregular trough, extending from the eastern limits of Long Lake, through Mud and Square Lakes, to Eagle Lake, and even beyond the latter, up the western branch of Fish River to Nadeau Lake, a total distance of twenty-five miles, with a probable change of level to the forks of not more than three or four feet. To the north, this trough is separated from the valley of the St. John by a range of somewhat prominent hills; but at its eastern end, in Long Lake, approaches the latter so nearly that not more than seven miles of distance divides the two. Thus, by simply traversing this short interval, from Frenchville on the St. John to the head of Long Lake, one has before him a continuous water-

channel and descending flow, through the chain of lakes, the main Fish River, and the St. John, back to his starting point, a total distance of over fifty miles, a fact which has made this route a favorite one for summer tourists. To the south of the lakes the land is again high, forming another parallel ridge, as well as a watershed between the two streams connected with these lakes, and the more numerous and larger ones which are tributary to the Aroostook. Through its west branch, however, Fish River approaches the last-named stream so nearly that we again have the curious occurrence of two considerable rivers, tributaries of a common trunk, approaching within a distance of five miles of each other, and yet flowing in different directions and by circuitous channels, a distance of not less than one hundred and ten miles to their actual confluence. In the case of the Aroostook itself, the irregular course of the channel is well illustrated in the fact that while the actual shortest distance from the town of Presquile to Andover, New Brunswick, is only thirteen miles, a traveller by rail, who follows the course of the river, has to traverse more than double the distance to reach the same locality.

If now we pass to the geological structure of the region, it is found that while the rocks exposed along the valley of the St. John above Edmunston, are entirely of slates, as are the beds in the lower part of the valley of the Aroostook—these slates, being quite similar to those which so frequently contain Silurian fossils over various parts of northern New Brunswick—the beds found in the troughs represented by Square Lake and its associated fossiliferous basins, on the one hand, and that of the Aroostook, about Ashland, on the other, are occupied largely by red and grey sandstones, with associated fossiliferous limestones. A similar contrast, also, is exhibited in the attitude of the beds, for while, along the slate-belts, these are commonly found to be greatly folded and disturbed, the Square Lake rocks, and those of the Aroostook, are generally much less folded, or are even horizontal. Such a contrast would at first suggest that the red beds and associated limestones are a newer and unconformable system reposing upon the slates, but this conclusion is seemingly negatived, not only by their stratigraphical relations, but by their contained fossils, and render it probable that the apparent horizontality and comparatively little disturbance along the lines indicated, are the result of these lines being coincident with anticlinal axes, along which the superincumbent strata have been washed away. The facts which led to the belief that all the rocks of the Lake Sedgewick basin, including the red sandstone, etc., as well the limestones, were older than the slates to the north, and therefore Silurian rather than Devonian, were fully detailed in the paper of last year referring to the subject. I may now give some of the additional facts, obtained with the assistance of Mr. W. McInnes, from a study of the district above Ashland, and along the valley of Aroostook River, between the last-named place and Presquile.

An interesting section of rocks is to be seen in the village of Ashland itself. Among these is a bed of limestone, similar in character to the limestones of Square Lake, and apparently holding similar fossils, but from which, owing to imperfect exposures, no recognisable species could be obtained. Above them, to the north, are grey, rubbly shales, while in the opposite direction, on the road to Masardis, and at a distance of about one hundred yards, are grey, buff-weathering sandstones and sandy shales, dipping northward, and holding soft, crumbling, ochreous bands and calcareous layers, which abound in crinoid stems and ribbed shells. Among the forms collected here were an *Eatonia* and *Spirifera*, both undetermined, a doubtful species of *Atrypa reticularis*, fragments of *Orthides* and other

brachiopods, together with a lamellibranchiate shell, resembling *Cypricardinia*. These are not sufficient to determine the exact geological horizon, but taken in connection with the other beds of the neighborhood, leave little doubt that they are Silurian. One mile south of Ashland village is another exposure of limestones, but, in the absence of instrumental measurements, it is impossible to say in what way it is related to the beds already described. It is, however, much more richly fossiliferous, and from it the following species, determined by Mr. Ami, were obtained :—

Favosites Gothlandicus, Lamarck.
Strophomena rhomboidalis, Wülckens.
 “ *punctulifera*, Conrad.
Melista arcuata, Hall.
Platyceras, sp.
Polypora Psyche? Billings.
Murchisonia, sp.
Loxonema Fitchi, Hall.
 A stromatoporoid form.
 Crinoidal columns.

These fossils indicate that the limestones in question, like those of Square Lake, are of the horizon of the Lower Helderberg formation. They were so regarded by Prof. Hitchcock, but by that author are further described as probably forming an anticlinal, upon the slopes of which the higher beds are to be regarded as Devonian. Of this view our observations failed to afford confirmation. Between Ashland and Presqu'île admirable opportunities are afforded for the study of the rock-formations of the district, first along the stage route connecting these two places, and secondly along the channel of Aroostook River. The last-named section, being the most complete, will be here described, with only incidental references to the former.

At the mill on Big Machias River, a quarter of a mile above its junction with the Aroostook, and half a mile from Ashland Bridge, are four exposures of grey, light-weathering slates, which are so calcareous as to approach limestones in character, and from which attempts have been made to obtain lime. Their dip is south-easterly at an angle of only twenty degrees. Similar beds are also exposed on the Aroostook itself, one mile below the bridge, and near the mouth of the Little Machias, but here their dip is much higher, being N. 60° W. < 70-85°. With these are beds of grey, buff-weathering, flaggy sandstones, which appear to be a continuation of similar beds seen on the right bank of the Aroostook, half a mile above the bridge, and which abound in plant remains, though too obscure to admit of identification. The dip is the same at both points, and their position would seem to be above that of the limestones just described. Between the two, however, it is probable that a band of green and red slates, with thin beds of calcareous conglomerate, intervenes, beds of this character appearing a mile or so further down the stream, in a manner which seem to indicate that they hold this position. Their dip is comparatively low, varying from N. 30° W. < 45° to N. < 30°. Similar beds may also be seen crossing the post-road between Ashland and Castle Hill.

For three or four miles below the last described exposures upon Aroostook River, making a distance of about seven or eight miles from Ashland, the dip of the rocks becomes reversed, being now south-easterly (S. 60-70 E. < 45° to 60°). They here consist largely of

grey sandstones, which are banded with paler layers, containing thin beds of grit with crinoids, but in part also of fine, bluish-weathering slates, both being of decidedly Silurian aspect.

About two or two and a half miles above the mouth of Beaver Brook, the sandstones and slates above noted are followed by great masses of very coarse conglomerate, filled with large, well-rounded pebbles of metamorphic rocks, as well as some composed of another conglomerate, imbedded in a thin, sandy paste, and which include sandy beds a foot or more wide, dipping very regularly S. 60° E. < 50°. These conglomerates are also well-exposed upon the Ashland Road, and large boulders, derived therefrom, are strewed over all the surrounding country. Their position, as seen on the last-named road, is probably beneath the sandstones, and they are remarkable in containing numerous fragments of black, siliceous slate, with others of green, jaspery slate, features in which they strongly resemble the conglomerates of the Fish River section, as they do others believed to hold a like position on Beccaguimic River, in Carleton County, New Brunswick, on Siegas River, in the same Province, and on Lake Temiscouata, in the Province of Quebec.

Half a mile below the above exposures, sandstones again come out in high bluffs upon the right bank of the stream, and are probably a portion of the same belt as that first noticed. Here, however, they are remarkable for their massive character, for their low dip (S. < 5-10°), and for their peculiar aspect, being conspicuously filled with little black specks, some of which are, undoubtedly, fragments of black slate, but of which others appear to be fragments of plant remains. They also contain fragments of dark-green serpentine. Besides the doubtful impressions referred to, the rock contains numerous, and in some instances well-preserved, shells and corals. In a collection here made, Mr. Ami has recognised the following:—

- Impression of a Coral resembling Favosites.
- “ “ Bryozoon, *probably* Callopora.
- Orthis, *sp.*
- Strophomena subplana ? Conrad.
- “ rhomboidalis, Wilckens
- Rhynchonella, *sp.*
- Spirifera, *sp.* (like *S. radiata*, Sowerby.)
- Atrypa reticularis, Lin.
- Cornulites (like *C. flexuosus*, Hall.)

Mr. Ami regards the above fossils as of about the age of the Niagara or Wenlock, in which case their position would be below the Lower Helderberg limestones of Ashland, but neither the stratigraphy of the beds or their contained remains have as yet been sufficiently studied to remove all doubt upon the subject. That they are Silurian, however, rather than Devonian, as they have been hitherto described, appears to admit of but little question.

Below the mouth of Beaver Brook, Aroostook River exhibits several abrupt changes of direction, and thus alternations of what are probably the same beds are several times repeated along its banks. They include ledges of conglomerate and sandstone, similar to those above described, followed by dark, bluish-grey slates, which, at the southern point of the chief bend in the stream, shew a broad low anticlinal, one hundred yards in length, with a dip in either direction of not more than two or three degrees. Somewhat lower,

where the stream again turns to the east, and about half a mile below the mouth of a small brook coming in upon the northern side, are bluffs of grey calcareous slate, interstratified with thin layers of grey sandstone, and holding also thin layers of dark-blue compact limestone. They all lie at a low angle, and from this point, for a mile or more, exhibit along the shores a series of undulations, in which the folds are, for the most part, very broad and open, with very moderate dips (4° or 5°), but which also include some more abrupt corrugations, with dips as high as 80° . The slates have a strong cleavage, with an underlay N. 50 W. $> 80^{\circ}$, and have also a pale-greenish tinge, which, by weathering, sometimes becomes quite pronounced. The limestone layers are from three-fourths to one and a quarter inches in thickness, being separated from each other by about six inches of slate, and where first seen form continuous sheets, but somewhat further down they exhibit the remarkable peculiarity of being transversely and abruptly broken into separate pieces, from one or two inches to a foot in length, as though the whole rock had been shattered by the passage of violent vibrations—a feature which is exactly repeated in similar beds, having similar associations, on Siegas River, in Victoria County, New Brunswick. Much of what has been called limestone upon this river is really only a highly calcareous slate, which weathers somewhat like the first-named rock, but there are also, in places, numerous thin bands alternating with the slates, of nearly pure, dark-blue limestone, seamed with spar. The last beds visible upon the stream are to be seen about three quarters of a mile above the mouth of Salmon Brook, in Washburne, below which the river is bordered by low banks and intervalles. It is near this point that, in the fields above the river, occurs the bed of iron-ore referred to by Prof. Packard, in Hitchcock's Report. This, not outcropping upon the stream, was not seen by the writer, but its position would, apparently, correspond to that of the red and green slates, which are elsewhere, both in Maine and New Brunswick, so generally associated with such ores.

If now the above section upon the Aroostook be compared with that given in my paper of last year, as seen on the East Branch of Fish River, it will be found that, if the conclusions above stated are correct, there is between the two a very close correspondence. Thus, in the Fish River section, we have—

Grey, reddish and brown sandstones and shales, associated with beds and enclosing masses of fossiliferous limestone.

Grey calcareous conglomerate, with pebbles of dark flinty slate, jasper, etc.

Grey calcareous and buff-weathering sandstones, with crinoids and shells.

Grey and dark-grey slates, with remains of plants.

Grey, bluish-weathering calcareous slates.

and upon the Aroostook—

Grey, reddish and brown sandstones, containing fossiliferous calcareous layers, and associated with beds of highly fossiliferous limestone.

Green and red slates, with thin beds of calcareous conglomerate.

Heavy beds of coarse conglomerate, with pebbles of black siliceous slate, green and red jasper, etc.

Grey sandstones, often buff-weathering, with numerous remains of shells and corals, mingled with fragments of plants, small pieces of black slate, and occasionally of serpentine.

Grey, dark-grey and greenish, calcareous slates, with thin bands of limestone, and beds of hematitic iron.

Grey, bluish-weathering calcareous slates.

The fossiliferous limestones of both of these sections have been alike referred, by Mr. Billings and Mr. Ami, to the Lower Helderberg formation, and of this reference the variety and perfection of the fossils leaves no doubt. But while, in the Maine reports, the associated beds are described and represented as Devonian, the facts here given would seem to indicate that these also are rather to be regarded as Silurian. It is true that the Oriskany formation, to which these beds have been referred, is variously regarded as pertaining to either or both of these systems, but in the sandstones of the Aroostook, described above, not even Oriskany species have been found to occur, the facies of the shells being rather that of the Niagara formation. Moreover, if, as the facts both here and elsewhere indicate, the fossiliferous sandstones are succeeded by the great masses of calcareous slate, which spread so widely over northern Maine and the adjacent portions of Quebec and New Brunswick, and which, at many points, contain Silurian fossils, a considerable thickness of strata must intervene between the fossiliferous limestones and the real summit of the Silurian system in this region. It may be added that an almost exact parallel to the succession as here given in Aroostook County, Maine, is repeated, with abundant fossils, on the shores of Lake Temiscouata, and will form the subject of a forthcoming Report in the volumes of the Geological Survey.

By the above observations it is by no means intended to indicate that no Devonian, or at least no Oriskany beds are to be found in northern Maine. On the contrary, the existence of the latter would appear to have been well established by the occurrence of characteristic fossils at a variety of points, and similar beds have recently been discovered by Mr. W. McInnes, in the Upper Tobique region, in New Brunswick. But that much of what has been so regarded in Maine is really Silurian, seems, from the observations here given, to be placed beyond reasonable doubt. The only beds seen by the writer within the district visited which are certainly newer than Silurian, are a series of soft brownish-red sandstones and conglomerates, which may be seen three or four miles from Presquile, on the road to Ashland, and which repose, with little inclination, upon the highly-tilted Silurian slates, elsewhere abundantly exposed along the same highway. These have also been regarded, in the Maine reports, as Devonian, but it is quite as probable that they are Lower Carboniferous, bearing, as they do, the closest resemblance to the beds of this age seen in the Tobique valley and elsewhere in the Province of New Brunswick.

It is much to be desired that a thorough resurvey of the County of Aroostook should be made, and more ample collections be obtained and examined from the numerous and exceptionally rich fossiliferous strata which it contains.